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AUTHOR LeBlanc, John F.; And Others
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ABSTRACT

The "Preparing Elementary Teachers to Teach Mathematics (PETTM) Project" (1988-1991) was a cooperative university/school effort to improve the teaching of mathematics by elementary teachers with its primary focus on improving the university training of preservice teachers (PSTs) in mathematics. This document, volume III of the project's 5-volume final report, describes the "Methods Component" of the project. The report is divided into four sections: an introductory section providing the background and rationale for the project and a description of its four components, and three sections describing respectively the early field experience associated with the mathematics methods course, the Math Tutorial Program designed to give volunteer PSTs the opportunity to gain additional experience with children while refining their teaching skills, and the design, construction, and utilization of the problem data bank developed for the course. Publications and presentations related to the methods component and a description of related instructional products are provided. (MDH)

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Preparing Elementary Teachers to Teach Mathematics:

A Problem-solving Approach

Final Report

National Science Foundation Grant TEI 8751478

Volume III: Methods Component

John F. LeBlanc
Coordinator of the Methods Component
Project Director & Co-principal Investigator

Frank K. Lester, Jr.
Co-principal Investigator

Diana Lambdin Kroll
Project Manager

Report Prepared by

Charles E. Emenaker
Jacqueline Gorman
John F. LeBlanc
Annette Ricks Leitze

Members of the Methods Component Team

Monica Cougan
Charles E. Emenaker
Jacqueline Gorman
Annette Ricks Leitze
Margaret Pritchett
Anne M. Raymond
Lynda Wiest

Technical Assistance: Andrew McGuire & Kelly Murphy

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MATHEMATICS EDUCATION DEVELOPMENT CENTER
School of Education, Indiana University, Bloomington, IN 47405

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PREPARING ELEMENTARY TEACHERS TO TEACH MATHEMATICS: A PROBLEM-SOLVING APPROACH

OVERVIEW OF THE ENTIRE PROJECT

The *Preparing Elementary Teachers to Teach Mathematics Project* (1988-1991) was a cooperative university/school effort to improve the teaching of mathematics by elementary teachers. The primary focus of the project was the improvement of the university training of preservice teachers (PSTs) in mathematics. In the late-1980s, Indiana University had been involved in making plans to institutionalize a new four-year program for elementary education majors in 1989. Two elements of this new program were directly related to the work of the *Preparing Elementary Teachers to Teach Mathematics Project* (*PETTM*). These two elements are:

1. each elementary education major must complete an 18-24 semester credit hour concentration in an approved area (one of those areas being mathematics); and
2. each prospective elementary education major must take part in a three semester sequence of concentrated early field experiences working in a school prior to student teaching.

The goals of the *PETTM* Project included:

1) better preparing all elementary school teachers through a problem-solving focus in newly developed mathematics courses at the university;
2) developing a program of concentration in mathematics consisting of some existing courses and some newly developed courses and experiences to prepare students who wish to make mathematics their field of concentration;
3) developing a close working relationship with the local school district to jointly plan for intensive early field experiences for all prospective teachers;
4) establishing support mechanisms to help practicing teachers in the school district broaden their views of the nature of mathematics and to help them utilize innovative teaching techniques for improving their pupils' mathematical thinking skills and use of problem-

solving strategies. As a result, local teachers should eventually be able to serve as role models in the teaching of mathematics using a problem-solving approach for the prospective teachers who visit their classrooms.

Background and Rationale

A number of national reports published in the mid-1980s called for the improvement of education at all levels. Three reports which attracted national attention were the NCATE Redesign (Gollnick & Kunkel, 1986), the Holmes Group report (1986), and the report of the Carnegie Task Force (1986). Based on the assumption that the quality of education is directly related to quality of teachers, these reports proposed dramatic changes in the practices used in recruiting, preparing, and certifying elementary school teachers. Both the Holmes Group and the Carnegie Task Force reports called for the elimination of undergraduate programs. All of the reports proposed broader and deeper backgrounds in liberal arts. The reports also called for closer ties and working relationships between teacher preparation institutions and school districts.

An elementary education Task Force at Indiana University studied the reports and, while seeing merit in many of their recommendations, declined to join the Holmes group. Although educators at Indiana University certainly agrees with the need for graduate work in education, they also feel that such study is more profitable after some teaching experience has been acquired. Further, the Task Force believed that it is quite possible to train elementary school teachers in a well designed four-year program (cf., Mehlinger, 1986). Thus, in 1989, Indiana University instituted their new four-year elementary education program, a program which incorporated many of the recommendations common to the reports mentioned above. Faculty in Mathematics Education and in Mathematics at Indiana University saw the revision of the teacher education program as a unique opportunity to improve the mathematics preparation of elementary teachers.

Project Description

The *Preparing Elementary Teachers to Teach Mathematics Project* was comprised of four components, all of which were designed to contribute to improving mathematics instruction in elementary schools: the *Content Component*, the *Methods Component*, the *School Component*,

and the *Research and Evaluation Component.*

The *Content Component* involved revision of the university mathematics courses required of PSTs in a fashion that could be exported to other teacher training institutions. Under the new Elementary Education program, prospective elementary teachers would take two mathematics courses: a finite mathematics course (M118—already required of freshmen intending many majors) , and a newly designed mathematics course specifically for education majors (T104). Under project auspices, the former course was restructured and the latter designed completely from scratch, so that problem solving is now a central focus in both. In other words, efforts are now being made to teach university-level mathematics with the same problem-solving approach that the Project would like to see teachers use when they work with children.

The *Methods Component* of the Project had three major goals: 1) to develop well-structured field experiences for both the existing mathematics methods course and a proposed new problem-solving methods course, 2) to develop and institutionalize the new problem-solving methods course (to be required, along with additional mathematics courses, of those students who would elect mathematics as their area of concentration), and 3) to develop a computerized problem-solving data bank to be available for use not only by students enrolled in methods classes and field experiences, but also by prospective teachers in other courses and local teachers in the schools.

An important part of the training of PSTs is experience with classroom teachers and their students. The purpose of the *School Component* of the Project was for Indiana University faculty to work together with faculty from a local elementary school (Dyer/Highland Park) to provide the best possible environment for early field experiences in mathematics for IU students. A full-time resource teacher worked closely with the Dyer/Highland Park School faculty for three years, helping them develop the confidence and expertise necessary to teach mathematics using a problem-solving approach. Five teachers from the school worked for two summers writing books of problem-solving materials that they, and their colleagues, could use with their students. The university-school partnership was a very successful part of the project.

The main purpose of the *Research and Evaluation Component* was to determine the

effectiveness of each of the other components of the project. A long range goal of the entire project was to provide an improved model for training elementary teachers. By finding out which innovations were effective, the project was able to provide a tested plan for training elementary teachers to teach mathematics.

Conclusion

The *Preparing Elementary Teachers to Teach Mathematics Project* was multifaceted, aiming to improve the teaching of mathematics in the elementary schools by encouraging teachers to use a problem-solving approach. Although the major focus of the Project was the design and implementation of a new program of studies for prospective elementary teachers at Indiana University, an essential element in this endeavor was the establishment of Dyer/Highland Park Elementary School as a site for all Project-related field experiences, and the provision of frequent and ongoing inservice work for the Dyer/Highland Park faculty so that school could serve as a model site for the teaching of mathematics with a problem-solving approach.

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PREPARING ELEMENTARY TEACHERS TO TEACH MATHEMATICS: A PROBLEM-SOLVING APPROACH

Overview of the Methods Component

The *Methods Component* of the Project had three major goals: 1) to improve the field experience (M201) accompanying the existing mathematics methods course as well as develop a well-structured field experience (involving mathematics tutoring as well as problem-solving instruction) to accompany a proposed new problem-solving methods course, 2) to develop and institutionalize the new problem-solving methods course, and 3) to develop a computerized problem-solving data bank to be available for use not only by students enrolled in methods classes and field experiences, but also by prospective teachers in other courses and local teachers in the schools.

The Early Field Experience: M201

M201 is the early field experience associated with the mathematics methods course for preservice elementary teachers (PSTs), *Mathematics in the Elementary School* (E343). The first eight weeks of the semester is the mathematics field experience, while the remaining weeks are devoted to the science field experience. If the students are following the prescribed sequence of courses, this will be their first formal teaching experience. Most of the PSTs have already observed students in a classroom and some have tutored an individual student.

Philosophy of M201

The philosophy of M201 is consistent with that of E343 in that both emphasize hands-on, manipulative experiences for the students, and view the role of the teacher as that of a facilitator of learning rather than a dispenser of knowledge. Both of these courses have philosophies aligned with the *Professional Standards for Teaching Mathematics*, published by the National Council of Teachers of Mathematics in 1991. One constraint in integrating M201 and E343 has been that the mathematics field experience takes place during the first eight weeks of the semester. Thus, sometimes PSTs teach lessons on mathematics content that has not yet been discussed in the methods course. M201 also builds upon the cooperative learning philosophy of E343 and the mathematics content course, Mathematics for Elementary Teachers Via Problem Solving (T104), in that the PSTs work cooperatively to plan lessons on which elementary students will work cooperatively.

The M201 mathematics experience is a combination of workshops on campus, small group teaching in a local elementary school, and group seminars involving PSTs and supervisors. The

class is scheduled for a 2 hour and 45 minute block of time each week. Responsibilities with the small group include teaching a model lesson and teaching a three-lesson unit. The units are planned through individual and/or group conferences with the M201 supervisor. This field experience is designed so that the PSTs will work with a small group of children, usually three or four, in an elementary classroom. This allows the PSTs to concentrate on their teaching skills and on how children learn mathematics without the added pressure of managing a large group of students. Later in the field experience series (M301 and M401) each PST will experience teaching a unit to an entire class of elementary students.

The M201 field experience is based on a problem-solving approach to teaching. Workshops and lesson assignments are designed to encourage the PSTs to use questioning techniques to elicit information from the students, rather than telling the students the what to do or how to do it. Consistent with this approach, active participation on the part of the learner is essential. Workshops and lesson ideas are motivated by the goal of complimenting textbook curricula with problem-solving oriented, hands-on learning. The PSTs are encouraged to incorporate these active learning concepts into their own lesson plans and teaching. M201 also provides the PSTs with the opportunity to interact with Highland Park classroom teachers, learn about the elementary students in the teachers' classrooms, and discuss how M201 fits with the problem-solving curriculum at Highland Park.

What Changes Were Made in M201 During the Project?

Prior to the start of this project M201 students were sent to a number of different schools to teach a variety of topics to small groups of students. The goals for M201 under this project were to have all the students have this early field experience at only two schools and to have better planned visits take place. To this end, arrangements have been made with Highland Park Elementary School, (formerly called Dyer Elementary School) and Grandview Elementary School to have all the M201 students placed in classrooms at these schools for their mathematics field experience. Note that the PSTs work with the same elementary students for their early science field experience.

Furthermore, the M201 course has been organized and materials developed to achieve the goal of better planned field experiences both for the PSTs and the elementary students. An instructor's manual that was developed for use by M201 instructors has been prepared provides organizational features of the course, teacher notes for each weekly meeting, practical hints and suggestions and the model lesson plans. The course has been organized in the manner described below.

Organization of the Course

Week 1: Organizational Workshop -- This workshop explains the field experience and orients the PSTs to the course expectations.

Week 2: Model Lesson Workshop -- This workshop prepares the PSTs to teach their first lesson. Grade-appropriate lessons were prepared during the NSF project and are used by the PSTs for their first teaching experience. The PSTs watch a videotape of an experienced teacher teaching the lesson to a group of students. The class discusses the videotape to gain a sense of what the objectives of the lesson were and how the teacher achieved the objectives.

Week 3: The third meeting of the M201 field experience involves a teaching session and a debriefing seminar. PSTs will meet at their field placement sites. Each PST will teach her small group the lesson that was viewed and discussed the previous week. Following the small group instruction, PSTs meet with their supervisor for a 30 minute seminar to reflect upon their teaching experience.

Week 4: Lesson Planning Workshop -- This on-campus workshop is designed to aid the students in developing workable lesson plans for the remainder of the field experience.

Week 5: Progressive Lesson Workshop -- This on-campus workshop involves the PSTs working with their supervisor and colleagues in designing their remaining small group lessons. The content area for the lessons is chosen by the M201 instructor each semester.

Week 6: During this week of the field experience the PSTs have the opportunity to teach the lesson plans which they developed the previous weeks. They meet for a 45 minute teaching session followed by a 30 minute seminar. In some cases, PSTs observe other PSTs teaching an additional 45 minutes.

Week 7: Same as week 6.

Week 8: Same as week 6.

Model Lesson Plans and Videos

Under auspices of the Project, four complete model lesson plan series were developed for M201. Each series is composed of three lessons on a specific topic and has an accompanying videotape. The three lessons are for primary (K - 2), intermediate (3 - 4), and upper elementary (5 -6). Below is a list of the model lessons series developed through the project.

Graphing Series		Geometry Series	
K-2	Bar Graphing	K-1	Shape Recognition
3-4	Coordinate Grid	2-4	Line Symmetry
5-6	Frequency Distribution	5-6	Three-Dimensional Shape Recognition

Number Theory Series		Rational Number Series	
K-1	Odd and Even Numbers	K-2	Introduction to Rational Numbers
2-4	Prime and Composite	3-4	Rational Numbers Using Region Models
5-6	Figurative Numbers	5-6	Rational Numbers Using a Relational Perspective

The following description of the Geometry 2-4 Line Symmetry videotape and lesson provides an illustration of the model lesson series. Each videotape is 45 minutes in length, demonstrates the use of some manipulatives, and shows a teacher using a model lesson with a group of children. The Line Symmetry videotape begins with the teacher having the children cut a heart out of folded paper. This serves as a launching point for the lesson on line symmetry. The children use miras to look at the line of symmetry on the heart.

After some discussion the teacher instructs the children to cut out any shape they want from folded paper. The children again use miras to explore any lines of symmetry on their shape, looking for as many lines of symmetry as possible. The lesson continues with the teacher having the children examine pattern blocks (one at a time), looking for lines of symmetry with the miras. The last activity shows the children working with the outlines of pattern block figures. The children fill in the figures with pattern blocks and use miras to look for all possible lines of symmetry. The teacher wraps up the lesson with a discussion of what the children have learned about line symmetry.

In addition to watching the videotape, the PSTs are given the written lesson plan for the particular model lesson they will teach. This lesson plan includes the concept being taught, the purpose, rationale, prerequisites, materials, vocabulary, lesson outline (setting the stage, development of lesson, closure), and ideas for gearing the lesson up or down.

To avoid the situation of elementary students being taught the same lesson twice in one year, or even two years in a row, the model lessons used are rotated. For example, in the fall semester of an academic year the graphing series would be used. In the following spring semester the rational number series would be used. The geometry series would be used in the fall semester of the next academic year, followed by the number theory series in the spring. The Mathematics

Education Development Center is planning to make the videotapes and viewing guides available for purchase in the near future.

A fifth model lesson series was also developed but videotapes have not yet been made. The series is the Place Value Series. The different lessons are as follows:

Place Value Series

1-2 Introduction to Grouping and Regrouping

3-4 Addition With and Without Regrouping

5-6 Division

Progressive Lessons

The content area for the progressive lessons that the PSTs plan cooperatively with each other is chosen by the M201 instructor. One semester solid geometry was the chosen area. The PSTs working with a second grade class designed a three-lesson unit with the goal of having the children become familiar with and develop an understanding about three-dimensional objects. The first lesson began with "Find It" -- an activity where the children looked for two-dimensional shapes, such as circles and squares, in pictures. Next, some wooden solids were introduced -- sphere, cone, cylinder, cube, rectangular prism -- and the children played "Mystery Shape" -- an activity where children take turns reaching into a covered box, grasping and feeling one three-dimensional solid, and then describing the solid to the other children for them to identify.

The second lesson continued with the use of the wooden solids, playing "Roll, Stack, Slide" -- an activity where the children investigated which solids would roll, stack, and/or slide. The discussion following this activity focused on the differences between the solids and why some solids roll, stack, slide and others do not. The children also examined magazines, looking for solids in everyday life. In the third lesson the children made three-dimensional solids out of play dough and discussed the faces, edges and corners of the solids.

School Math Fair

During two years of the NSF project, the PSTs doing their M201 field experience at Highland Park in the spring semesters participated in the Highland Park Math Fair. Students in each Highland Park classroom were presented with a problem, which they solved in small groups with the aid of a PST who was participating in M201. In this case the math fair problems took the place of the progressive lessons taught by the PSTs during the sixth, seventh and eighth weeks. The PSTs planned a three-week sequence for the math fair problem-solving experience. Examples of problems/projects used for the fair are designing a playground using a specific budget, finding the most common letter in the alphabet, and determining the most popular lunch served by the cafeteria. In addition to solving the problems, groups of students prepared hands-on explanations for their parents. The results were displayed during an evening fair in which parents visited the

school to see their children's ingenuity as well as to attempt to solve similar problems.

Responses from PSTs enrolled in M201 indicate positive attitudes toward the course. The PSTs especially like the contact with a small group of children, which they find non-threatening and a good opportunity to develop some instructional methods. PSTs have also expressed enthusiasm for the model lessons and appreciate having an example of a good lesson to use in developing their own lessons.

The Mathematics Tutorial Program

An area of deficiency in the current preparation of pre-service teachers (PSTs) is that of firsthand experience in diagnosis and remediation of students' computational errors. Without the ability to diagnose these computational errors, classroom teachers fail to understand the students' perspective, thus making successful remediation difficult if not impossible. One of the inital objectives of the methods component of the project was to develop a diagnosis and remediation center at the site of the school experience component, Dyer Elementary School. This center was to provide supervised experiences for PSTs in diagnosing and remediating students' computational errors.

Development of the Mathematics Tutorial Program

Research into other such centers across the nation was conducted and contact made with professors who were involved with these centers, at the time. Included in the contacts were Mahesh Sharma at the Center for Teaching/Learning Mathematics in Framingham, MA and Dr. Carol Thornton at the Illinois State University Mathematics Learning Clinic in Normal, IL. After talking with Dr. Thornton and her graduate assistant, it became evident that a great deal of manpower was required to run such a program. Because qualified PSTs would not be available to operate the center until the problem-solving course (N443) was offered, it was clear that the pool of capable personnel to man the center would not be available. The original plan was then revised to a Math Tutorial/Homework Program.

It should be noted that the Illinois State University Mathematics Learning Clinic incurred similar problems with a sufficient pool of capable personnel once state requirements were changed to require undergraduates to select an area of concentration. The new state requirements mandated that they take an additional 18 hours of content coursework in their area of concentration. This 18 hours of coursework prevented the undergraduates from having sufficient time to take the methods course needed to work in the center. Because this course provided the trained personnel for the center, the manpower necessary to operate the center was unavailable and the center closed.

The Math Tutorial/Homework Program (MTP) began during the fall of 1989 providing during-school tutoring and after-school homework help to Dyer Elementary School children. We sought volunteer tutors who had been observed successfully working with children in earlier mathematics field experiences and were:

- independent learners,

- enthusiastic about learning,
- knowledgeable in the use of manipulatives, and
- eager to work with children.

A list of recommended pre-service elementary school teachers was obtained from the math methods and field experience instructors. These PSTs were invited to become tutors in the program.

A concurrent step was to locate classroom teachers willing to allow tutors to remove children from the classroom and willing to identify pupils needing extra help in mathematics. This was intially engineered through the project's school coordinator/resource teacher, Jacqueline Gorman, at Dyer Elementary School.

Although the tutorial program went fairly smoothly the first semester, we experienced difficulties with the after-school homework program. Students loitering around the school building during the homework help sessions distracted both the students seeking homework help and the tutors. However, the most serious problem arose when parents would not arrive at the designated time to pick up their children. In those cases, the tutor had to wait with the child for up to 45 minutes causing the tutor to miss other scheduled commitments. Following a review and discussion of the homework program we decided to discontinue it. We felt for the homework program to be successful it was necessary to have a commitment and a sense of responsibility from the elementary school which housed the program. For the elementary school to have such ownership may well mean that the elementary school must be the one to initiate the program.

Current Structure of the Mathematics Tutorial Program

Although the homework program was dropped, the Mathematics Tutorial Program (MTP) has continued and after four semesters of operation has developed into a smoothly operating program. We have always attempted to include the tutors in planning future semesters of the program. They have given us valuable information and help regarding improvements we could make in the MTP. The current structure of the program reflects their suggestions.

Currently, the MTP program operates for two six-week segments each semester. During each segment every participating PST volunteers one hour a day, twice a week to tutor elementary school children. The tutor removes one child from the classroom on each of two days during the week for a 30-minute session. Then, returning the first child to the classroom, the tutor removes a second child for a 30-minute tutoring session. This kind of schedule provides one hour of contact between tutor and child each week allowing the tutor to see growth over the six-week segment. At the end of each six-week segment the tutor is permitted to continue working at the same grade level, change to a different grade level or discontinue participation in the program. Continued participation for the duration of the semester is encouraged but not forced. In several cases the tutors have developed a sense of commitment to the children, tutoring beyond the end of the university semester.

Individualized consideration for placement is given to each PST. One consideration is to place PSTs at grade levels where they have had no prior teaching opportunities, thus, broadening their grade-level experience. A second consideration is to place PSTs with teachers whose schedules appear to be compatible, with the actual tutoring schedule to be worked out between the PST and the classroom teacher.

In addition to meeting with the students, the tutors are required to meet weekly with the program coordinator. Initially, the meetings were group meetings which served as a source of support and ideas for handling difficulties encountered by individual tutors. This was useful because even though some tutors may not have encountered any specific problems or questions that week, they profited from the experiences of the other tutors. However, as the program grew and a larger number of tutors participated, finding a mutually agreeable time for this group meeting was no longer possible. A new means of tutor support was needed.

Consequently, we decided to require the tutors to check in weekly, at their convenience, with the program coordinator. This could be done either in person or via telephone. This presented two difficulties. First, some tutors did not check in regularly, thus requiring additional time from the coordinator to initiate the weekly contact. Second, in some cases the tutors would try to make contact, only to find the coordinator unavailable. In order to avert these difficulties in the future, we will require weekly scheduled appointments between the coordinator and an individual tutor.

The purposes of these weekly meetings are to provide support, manipulatives and resource materials to the tutors. During these meetings the program coordinator serves as a personal and professional resource person: in some cases acting as a sounding board while in other cases providing suggestions regarding remediation of a particular problem. To assist the tutors in their work with the children and to facilitate their gaining additional experience in use of manipulatives, the manipulatives and other resource materials are available for check out from the Mathematics Education Department.

A successful tutoring program such as the MTP requires that participating tutors and classroom teachers be made aware of their respective responsibilities from the onset.

Tutor Responsibilities

The responsibilities of the tutors include the following:

- Being prepared to commit time (approximately 2 hours per week for a six-week period) for the purpose of tutoring elementary school pupils in mathematics.
- Notifying the classroom teacher in advance if illness or other unexpected circumstances prevent tutoring that day.
- **Checking in with the program coordinator every week!** It may be a brief or extended meeting depending on the circumstances.
- Briefly (10-15 min.) talking with the classroom teacher **once each week** to:

a) receive direction on the concept/skill to work on with the pupil, and b) discuss pupil's progress to date on the tutored concept/skill. This can be done in person or over the phone. Arrangements for this meeting should be made with the classroom teacher.

- Attending a final meeting with the program coordinator and possibly other Indiana University Math Education personnel at the end of the semester.

Classroom Teacher Responsibilities

The responsibilities of the classroom teacher are similar:

- Identifying pupils needing extra help with math as well as the specific concept/skill with which they need help (e.g., you may want to provide examples from the text or elsewhere of the tasks the pupils cannot do or do not understand.)
- Briefly (10-15 min.) talking with each tutor **once every week** to:
  a) provide direction on the concept/skill to be tutored, and b) discuss pupil's progress to date on the tutored concept/skill. This may be done in person or over the phone.

Program Coordinator Responsibilities

The program coordinator has many responsibilities to both the tutors and classroom teachers as well as administrative duties including:

- securing lists of names of possible tutors from the methods and field experience instructors,
- securing classroom teachers interested in participating in the program,
- writing and mailing invitation letters to prospective tutors,
- arranging and attending initial meeting with prospective tutors,
- meeting with tutors each week to assist in giving ideas for activities and expose them to supplementary materials available for their use,
- talking to or meeting with classroom teachers every two or three weeks to ensure that things are going well from the their perspective
- composing a letter for each tutor's placement file, and
- composing and sending a letter of thanks to each of the participating classroom teachers thus promoting good will between the classroom teachers involved and program personnel.

Advantages and Opportunities

As we continue to have satisfied tutors, word has spread about the tutorial progam, and the program has grown. Each semester has brought both increased interest and numbers of participants in the program. In the fall of 1990 the program was expanded to include Grandview Elementary School. To date 37 different PSTs have participated in the MTP during one or more segments. Of the 37 PSTs, nine have participated in two or more segments.

In return for the PSTs' volunteer efforts we have offered them a choice of two options. They may earn one hour of credit to apply toward their degree or elect to have a letter, detailing their volunteer time and efforts, included in their placement file. Most students have preferred to receive the placement file letter.

We feel that the MTP offers many opportunities to PSTs, classroom teachers, and children. The MTP provides opportunities for the PSTs to:

- gain additional and meaningful experience with school children in a setting where group management is not a problem,
- refine their teaching skills,
- become more independent learners,
- further their experience teaching with manipulatives,
- experience working with children at grade levels other than those at which they have had previous experience, and
- demonstrate dedication to the profession through volunteer work.

The MTP also provides help to classroom teachers already burdened with trying to meet the individual needs of a classroom full of children. Finally, the MTP benefits the children in need of extra help in learning mathematics.

Classroom Teachers' Reactions

Feedback from the teachers involved with the MTP has been quite favorable. The most consistent reaction to the program is that it helps improve the children's self-esteem and confidence in math. As a result, the children are eager to work on math with their tutor. The teachers see the one-on-one situations and the fact that the tutors continually work with the same children to be particularly beneficial.

Classroom teachers are favorably impressed with the tutors involved in the MTP. They have found the tutors to be responsible with respect to being there at the designated time or contacting the school if absence is unavoidable. The teachers have also remarked that the tutors show a great deal of enthusiasm in working with the children. One tutor even purchased presents for her pupils; for one child it proved to be the only present she received for Christmas.

The only negative aspect the teachers see in the program is that it is currently funded with soft money. Because of this, as well as the inability of the university to allocate funds to support the MTP, the potential exists for the program to be discontinued next year.

Tutors' Reactions

The tutors' reactions to the program have been positive. This was not a complete surprise since participation is voluntary. Among the benefits most frequently and consistently mentioned by the tutors is the opportunity to gain additional experience working with children. The tutors also find the one-on-one time with the children especially rewarding since few discipline problems are encountered. Additionally, the tutors find this one-on-one time provides them with a good opportunity to focus on developing their teaching skills.

Other facets of the program that the tutors find valuable include the following. By working with the same children over a period of several weeks or months the tutors are able to see the students making progress. Having the same children on a regular basis also allows the tutors to

establish continuity in lessons, building upon lessons they have presented previously. For many of the tutors, it is a first chance for them to come to grips with the fact that some children, even after classroom instruction, still need additional assistance to grasp the concepts being presented. This is an eye-opening experience for many of the tutors. Finally, the tutors find the professional contact with experienced classroom teachers worthwhile.

For Continued Success

For successful continuation of the MTP three things must happen. First, a stable source of funding needs to be located. Since the schools which house the MTP are situated on the west side of Bloomington, we are investigating the possibility of obtaining financial support for this program from one of the industries on the west side of town.

With funding from other sources, the coordinator's position would be filled by a graduate student. To date, a graduate student has served in the role of the coordinator, thus having graduate students function in a similiar capacity in the future is not unreasonable. This would be a year long position to provide continuity and train a coordinator for the following year.

Training would be in the form of an internship available to a graduate student in the spring semester. The graduate student would serve as an assistant coordinator, facilitating a degree of familiarity with the program before assuming the coordinator's position in the fall. The assistant coordinator would receive three hours of graduate credit. Such an internship would provide the required experienced personnel with a minimum of expense.

Second, the program coordinator needs to be regularly available to meet with tutors. Since this position is not full time, it needs to be incorporated with other departmental responsibilities. We feel that the coordinator needs to also teach at least one section of elementary school math methods or field experience at the university. This helps in securing greater numbers of tutors.

Third, the program coordinator needs to try to expand the number of classroom teachers willing to consistently participate in the program. We have had 18 different classroom teachers participate in one or more segments of the MTP, three repeatedly participating. This is in part by design since, at Dyer/Highland Park Elementary School, we have purposefully tried to continually include new teachers in this aspect of the project. However, with the project coming to a close, we feel that it may be time to strive for a reliable pool of participating classroom teachers to serve as mentors for the tutors.

The Problem-solving Methods Course: N443

The new elementary education program at Indiana University requires preservice teachers (PSTs) to select a subject area for concentration. Areas of concentration are subject areas such as science, mathematics, language, and so forth in which a PST desires to develop additional expertise. In the case of mathematics this expertise extends beyond just the teaching of the subject to also include further study of the subject itself. To meet this requirement a new problem-solving course, *Teaching Elementary School Mathematics Problem Solving* (N443), was designed to

provide additional PST experience in both performing and teaching mathematical problem solving.

Realizing that teachers' beliefs significantly affect their classroom behavior, we were compelled to try to expand the PSTs' views of mathematics and instill in them confidence in their own mathematical abilities. We wanted the PSTs to develop an ability to foster the role that problem solving can and should play in all phases of teaching and learning mathematics.

Key to the problem-solving process is the ability to perform the required computations. To foster problem-solving processes and correct computational techniques, teachers must become actively involved in understanding the thinking processes in which their students engage. It is relatively easy for teachers to simply grade students' papers, noting only the number of correct or incorrect responses. But it is much more difficult to identify erroneous algorithms the students have developed, algorithms which have led to incorrect responses. Hence, we felt it important for the PSTs to receive instruction in and personal experience with diagnosing and remediating students' computational errors.

Course Description

This course was designed to focus on components related to the teaching and learning of mathematical problem solving in the elementary school. Before addressing the issue of teaching problem solving, we felt it important to sharpen the PSTs' own mathematical problem-solving skills. Hence, the initial weeks of the course focus primarily on improving the PSTs' own problem-solving abilities. PSTs are asked to identify and solve different kinds of routine problems (simple translation, standard one-step, and standard multiple-step) and nonroutine problems (puzzle, process, and project). PSTs work on identifying problem-solving skills and strategies as well as analyzing their own thinking processes involved during problem solution. Throughout the course, PSTs work on nonroutine problems on an almost daily basis and develop a a card file of problems to serve as a resource for their future teaching career.

Once the PSTs have had a variety of experiences solving mathematical problems, the emphasis of the course changes to that of teaching mathematical problem solving in the classroom. Although PSTs continue to solve nonroutine problems, their experiences are expanded to include the modeling of appropriate instructional processes using other class members as their "students." One issue addressed is the selection and creation of problems for classroom use. Factors affecting problem difficulty and prerequisite skills are identified. Then writing and analysis of problems, variations, and extensions are covered. As a culminating activity, PSTs consider appropriate teaching actions necessary before, during, and after a lesson to lead to a successful problem-solving experience. Topics considered in a successful problem-solving experience are organizing the classroom, designing a cooperative learning environment, and creating an appropriate classroom atmosphere.

One of the disadvantages of incorporating problem solving into any classroom is the difficulty of evaluation. Therefore, time is spent in N443 on purposes and techniques of

evaluating students' problem-solving performance, attitudes, and beliefs. Additionally, there is discussion about the evaluation of problem-solving instruction.

PSTs are required to develop lesson and unit plans for incorporating problem solving into the classroom at various grade levels. The role of problem solving in the introduction of some concepts and computational skills to increase student motivation and perceived usefulness are also addressed.

Consideration is also given to the evaluation and incorporation of presently available curriculum materials for classroom use in problem solving. PSTs examine textbooks from several major publishers to determine how problem solving is handled in the current textbooks. They also examine supplementary materials available for classroom use in problem solving including the Problem Solving Data Bank developed as part of this NSF project.

A second aspect of the course is that of diagnosis and remediation of students' mathematical errors. Issues addressed include looking for systematic error patterns in whole numbers, fraction computation, and decimal computation in elementary school students' work. PSTs are introduced to the Brigance Diagnostic Comprehensive Inventory of Basic Skills and shown proper techniques for administering any diagnostic instrument.

After diagnosis of systematic mathematical errors, emphasis is on the remediation of errors and teaching methods to avoid errors. Time is given to determining prerequisite skills and concepts needed for successful computation, as well as to strategies for remediation of various systematic mathematical errors.

Two kinds of field experiences with elementary school children accompany this course: problem solving, and diagnosis and remediation. The problem-solving field experience consists of 30-45 minute problem-solving sessions during each of four consecutive weeks. During these sessions the PSTs work in pairs to teach problem solving to small groups (4-5) of average- to above-average ability children in grades 3 - 6. The second type of field experience, diagnosis and remediation, follows the instruction in the use of diagnostic instruments, and appropriate administration and remediation techniques. In this second type of field experience, two elementary school children are assigned to each PST, who is then required to diagnose, determine an appropriate plan for remediation, and remediate the children's mathematical error(s). PSTs work individually with each child for two 30-minute weekly sessions over a six-week period. Upon completion of the diagnosis and remediation field experience, the PSTs write a case study detailing their diagnosis and remediation efforts.

Comments & Reflections

The issue of primary concern is the longevity of the course. There are at least two factors contributing to this concern. One is the small number of PSTs choosing mathematics as an area of concentration. This will result in a small number of students who will actually be required to take the course. Moreover, since all PSTs already have very full schedules very few will have the

opportunity to enroll in the course as an elective. Because of these difficulties, it may require heavy recruitment efforts to maintain adequate enrollment. A pilot section of the course was offered in the spring semester of 1991 but was cancelled due to low enrollment. Enrollment in the course during the spring semester of 1992 was only six students.

Another problem relates to the problem-solving field experience accompanying the course. By the time the PSTs enroll in this course they have already had the M201 field experience (accompanying their regular mathematics methods course) in which they teach math to small groups (3 - 6) of elementary school children. Since the PSTs will soon be student teaching, and responsible for an entire classroom of children, an experience with a larger number of students would be quite beneficial. For these reasons, we thought it would be helpful if this field experience allowed the PSTs to work with at least ten to fifteen elementary school children at a time, if not the whole class. However, finding consenting teachers and classroom space to accommodate ten to fifteen children (approximately half of a class for each PST) proved to be a scheduling problem. Hence, the problem-solving field experience consisted of work with small groups of children.

We struggled over whether the field experience should be scheduled as a lab time or if it should be individually arranged for each PST. If the field experience were scheduled as a lab time, then all of the PSTs would have been teaching at the same time. Finding a sufficient number of classrooms (6 - 12) available at the same time for the PSTs could prove to be difficult, particularly since M201 uses a substantial number of classrooms each week. Thuse the field experiences have been scheduled individually (i.e., a separate time was individually arranged for each PST). This made supervision by Indiana University personnel virtually impossible. However, to burden the classroom teacher with the added responsibility of supervising the PSTs was, in our view, unacceptable. Thus, we had to rely heavily on the integrity of the PSTs for following through with their commitment. It proved to be no problem.

We have had extended discussions concerning the inclusion of diagnosis and remediation in the course. Inclusion of diagnosis and remediation in this course introduces two questions. First, since this is a course on problem solving, there is some question whether time should be given to additional topics not directly related to problem solving. The second question is if there is time to adequately cover problem solving, diagnosis, and remediation in the same course. Although diagnosis and remediation is not directly related to problem solving, we feel that the ability to diagnose and remediate children's computational errors is an important aspect of a classroom teacher's responsibilities. At present, this topic is largely ignored in the preparation of PSTs due to time constraints in other classes. Since we feel that any PST choosing math as an area of concentration should be knowledgeable in the use of diagnostic instruments, remediation materials, and remediation methods, we are of the opinion that there is both time and need for diagnosis and remediation in the course.

The Problem Data Bank

Problem solving is playing a more significant role in the school mathematics curriculum. Problems used to teach problem solving include more than just routine problems; non-routine problems are included as well. Currently, texts seem to provide an adequate supply of routine problems that are linked to one or more computational operations. These problems usually follow the development of a computational skill and provide direct applications of that skill to a real world situation. However, instruction in problem solving should include experiences with non-routine problems as well as routine problems. Many current textbooks, as well as a number of booklets and dedicated ancillary materials, now contain a fair number of non-routine problems for instruction in problem solving. There is however, a need for a single source of non-routine problems, a source that will identify many of the problem characteristics and prerequisite skills needed to arrive at a solution.

The majority of problems contained in ancillary materials currently available are classified at best by appropriate grade level and perhaps by suggested strategy for solution (e.g., working backwards, make a table, draw a picture, etc.). While this information is important, it is incomplete. With only this information the potential exists for the teacher to assign a problem to the class and then discover that the solution requires knowledge of numbers and/or operations beyond the students' present level of development. We envisioned a problem data bank with a more detailed classification scheme to assist teachers in identifying appropriate non-routine problems better suited to their students' ability levels.

We were convinced that a problem data bank having a more detailed classification scheme would be a valuable asset in a variety of settings. Some of the settings include providing:

- problems for the Dyer Elementary School teachers writing the resource notebooks,
- problems for immediate and future use to pre-service teachers enrolled in methods classes,
- problems for the T104 instructors to use in their classrooms, and
- a large selection of class-ready, non-routine problems for classroom teachers as well as instructors in the form of books and software.

In this report we will discuss the design and construction of the problem data bank as well as its past and future uses. Dissemination attempts to date will also be addressed.

Design of the Data Bank

Before construction of the data bank could begin, we had to reach a consensus regarding what constitutes a non-routine problem. Non-routine problems include a combination of puzzles as well as process and project problems. They may be presented in geometrical, numerical, and/or real-life settings. Frequently non-routine problems present a situation in which the student cannot find a solution by simply applying a known algorithm (e.g., see Figure 1).

Source: Chuck
ID #: 441
Grade: I
Problem: Cheryl, an archeologist, found a message on a cave wall telling her where a treasure was buried. It read:

To the front of the cave now you go
and 1 step north you take.
Now travel east for just 5 steps
your journey you now make.
Next to the south your hunt will lead
for 14 steps no fake!
Alas now west for 30 more
as you go by the lake.
There's one last trip up to the north
for here's where the treasures laid.
How many steps you are to take
the pattern you must break.

How many steps to the north does Cheryl need to go?

Type: P
Info: S
Diff: H
Strat: P,T
Oper\#S: A,X,W
Content:
#Solut: 1
Related to:

Solution:
Cheryl needs to go 55 steps.

Figure 1

The solution may require the use of one or more operations and/or one or more strategies. In some cases a problem may require the problem solver to define what a best solution is or may not have just one best solution (e.g., see Figure 2).

Source: Ann Leitze
ID #: 101
Grade: I
Problem: Using a map of your state, find the best way to get from your state capital to another large city in your state. Define what you mean by best.

Type: J
Info: S
Diff: M
Strat: G,O,T
Oper\#S: A,S
Content:
#Solut:
Related to:
Solution:
Answers will vary by state.

Figure 2

For puzzle problems an "A-ha!" solution may occur. Project problems, coded as J in the Type field, are open-ended problems sometimes requiring the problem solver to formulate a problem statement. See Figure 3.

Source:	Chuck & Ann	**Type:**	J
ID#:	690	**Info:**	S
Grade:	A	**Diff:**	M
Problem:	Compute the number of kilowatt hours of electricity your hair dryer uses each month to dry your hair. How much does it cost to dry your hair for one month?	**Strat:**	C,O,T
		Oper\#S:	A,X,Div,Dec,F
		Content:	x
		#Solut:	+
		Related to:	
	Hints:		
	1000 watts = 1 kilowatt 1 kilowatt hour is a measure of the amount of electricity used to operate a 1000 watt appliance for one hour.	**Solution:**	Answers will vary.

Figure 3

Once non-routine problems were defined, the next step was to identify characteristics we felt beneficial for a more detailed classification system. The fields that were ultimately agreed upon include:

- ID#,
- Source,
- Grade level,
- Problem statement (including graphics as necessary),
- Answer(s),
- Problem type,
- Information type,
- Level of difficulty,
- Strategies,
- Operations involved and types of numbers involved,
- Content area,
- Number of solutions, and
- Problem related to (e.g., Fox and Goose, Handshake, etc.).

Several of the fields (viz., **ID#**, **Source**, **Problem statement**, **Answer**, and **Grade level**) were seen as being essential and need no further definition or justification for inclusion. The other fields were included for a variety of reasons. Problem type (**Type**) was seen as being important to separate the three types of non-routine problems: process, project, and puzzle. The information field (**Info**) is useful in identifying problems that also include derailers or have insufficient information for solution. It is worth noting that the vast majority of the problems contain sufficient information for solution.

Level of difficulty (**Diff**) further refines the ability to find problems appropriate to the class. For example, a fourth grade teacher looking for additional problems that would be relatively easy for the class could refer to the hard problems in the primary grade level.

Having solution strategies (**Strat**) identified allows teachers to locate a variety of problems illustrating thinking strategies students might use to solve the problem (e.g., guess and test, look for a pattern, make a model, etc.). Use of any of the four basic operations as well as the knowledge of decimals, fractions or whole numbers needed for problem solution are indicated in the **Oper\#S** field. Basic concepts like logic, money, ratios, geometry, spatial visualizations, and so forth involved in the problem solution are identified in the **Content** field. Inclusion of the **Oper\#S** and **Content** fields accomplishes two things. First, it prevents teachers from accidentally giving students a problem that requires skills or concepts yet to be developed. Second, it allows teachers to locate problems that reinforce a particular skill or concept.

The number of solutions field (**#Solut**) alerts teachers to those problems with more than one correct answer. Furthermore, teachers can intentionally select problems to demonstrate situations with multiple solutions. The related to field (**Related to**) facilitates locating problems isomorphic to well-known problems. This is especially helpful in group problem-solving situations where a teacher may wish to provide groups with similar yet different problems.

Within the fields the following descriptors were used.

Grade: P = Primary, I = Intermediate, A = Advanced

Type: P = Process, J = Project, Z = Puzzle

Info: IS = Insufficient, IC = Inconsistent, IR = Irrelevant
S = Sufficient

Diff: E = Easy, M = Medium, H = Hard

Strat: G = Guess & test T = Make a table
B = Work backwards A = Act it out

P = Look for a pattern M = Make a model
E = Use equations S = Simplify
L = Use logic C = Compute
D = Draw a picture CA = Use calculator
O = Make an organized list

Oper\#S: A = Addition, S = Subtraction, X = Multiplication,
Div = Division, W = Whole number only,
Dec = Decimals, F = Fractions

#Solut: 0 = None, 1 = Unique, + = Multiple

Consider Figure 4. This problem is of primary grade level (**Grade**), is a process problem (**Type**) and has sufficient information to arrive at a problem solution (**Info**). **Diff** shows the level of difficulty to be medium and **Strat** suggests strategies that can be implemented to solve the problem. In this case the strategies are guess and test, make an organized list, make a table, and act it out. **Oper\#S** identifies the operations needed to arrive at a solution as addition and subtraction. It also indicates that an understanding of whole numbers is required. **Content** indicates that some knowledge with money is neede to solve the problem. **#Solut** indicates that there is one solution to this problem.

Source: Ann Leitze
ID #: 27
Grade: P
Problem: Stacey was hiding four coins totaling 17 cents in her pocket. She told her brother, Shawn, that he could havethe money if he could tell her what the four coins were.

Shawn figured it out. Can you figure it out too?

Type: P
Info: S
Diff: M
Strat: G,O,T,A
Oper\#S: A,S,W
Content: Money
#Solut: 1
Related to:

Solution:
1 dime, 1 nickel, 2 pennies

Figure 4

After establishing the classification scheme and categorization of the problems, a check was necesssary to verify the accuracy of the problem categorization. All descriptors within each field were verified by several department members. Grade level, level of difficulty and strategies

were further verified by having elementary school students solve some problems in an interview -type setting.

Next, it was necessary to decide on appropriate software. Some of the desired capabilities of the software were the ability to search and sort by any field or combination of fields, the ability to wrap text within a field, the ability to import graphics, and the ability to select some subset of the fields and print this subset in a user-specified layout. Filemaker II by the Claris Corporation best met these criteria.

Construction of the Data Bank

Initial acquisition of problem ideas came from a broad variety of sources including texts, resource books, and department personnel. Once a large base of problems was collected and entered into the computer, the problems were carefully scrutinized to eliminate those which were not consistent with our definition of non-routine problems.

At this point modification of the problems began. During problem modification consideration was given to the following areas: appropriateness for grade level, space limitations within the problem statement field, and attention to the inclusion of names representing diverse cultural backgrounds. Once the problems were modified, those problems requiring graphics were identified. The graphics required, as in Figure 5, were designed and imported using graphics software.

Source: Chuck (mod) Dilley, C. & Rucker, W. **Type:** P

ID #: 344 **Info:** S

Grade: I **Diff:** M

Problem: Highland Park has several trails for bikes as pictures below. They want to have a bike-a-thon where the bikers ride all sections of the trail, but ride each section only once. They can ride through intersections more than once but are never allowed to be off of the trail. **Strat:** L

Oper\#S:

Content:

#Solut: 1

Related to:

Which of the trails can be used for the bike-a-thon?

Solution:

a, c, and d will work for the bike-a-thon.

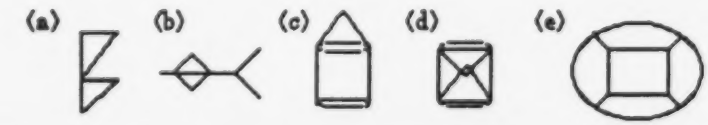

Figure 5

It is important to note that while new problems were being developed and entered into the computer there was a repeated editing of problems already in the system. This editing process was carried out by several department members. The purpose of this was to eliminate errors, provide several editing perspectives, and check for duplication of problems.

Once or twice each year an analysis of the data bank contents was made. This ensured that the data bank included problems illustrating a diversity of strategies at each grade level. When deficiencies were found, efforts were made to introduce problems in the needed areas thus preventing a skew to one grade level or strategy.

The data bank currently consists of 474 problems: 109 primary problems, 204 intermediate problems, and 161 advanced problems. The reason for a smaller number of primary level problems is the fact that many problems at this level require extensive graphics, graphics which were beyond the capabilites of our software, to compensate for students' limited reading abilities.

Uses of the Data Bank

Past Uses

Problems from the data bank have been used by the instructors of T104, a mathematics content course for pre-service elementary school teachers at Indiana University. T104 instructors used the data bank as a source for test problems. Problems from the data bank have also been used when teaching different problem-solving strategies in E343, a mathematics methods class for pre-service elementary school teachers. Additionally, the data bank was made available to the Dyer Elementary School teachers who wrote problem-solving resource books during the summers of 1989 and 1990.

Numerous personal requests for problems fitting specific needs have been made by department members. The data bank has been used to provide problems for department member presentations in local elementary schools. Some problems from the data bank have been submitted for publication in the Mathematics Teacher calendar. Others have been modified and used to accompany an article to be published in the Arithmetic Teacher.

Future Uses

The data bank will continue to be regularly used in the preparation of pre-service elementary school teachers in both the T104 and E343 classes. Pre-service elementary school teachers as well as department members will continue to have the data bank problems as a resource for preparing presentations in elementary school classrooms.

It is our intention to increase the use of the problem-solving data bank in in-service workshops for teacher enhancement. Using the problem-solving data bank for in-service workshops will help teachers to personally experience a broad spectrum of problem-solving strategies at different levels of difficulty. Once they have personal experience with problem solving they will be better equipped to provide similar problem-solving experiences for the students in their classrooms.

Dissemination

We have struggled with whether or not the data bank should be disseminated in book form or as software. The advantage to dissemination in book form is that it would be accessible to a larger number of teachers since it would not require experience with a computer or Filemaker II software. A disadvantage to dissemination in book form is the inability to perform the searches and sorts possible using Filemaker II. This ability to perform searches and sorts makes the data bank a unique and powerful tool.

Factors that we see as limiting distribution of the data bank in a software format are:

- teachers' inexperience with computers and software,
- teachers' inaccessability to the necessary hardware, and
- potential expense involved in the purchase of Filemaker II.

Attempts to date for dissemination in a software format include contacts made with Addison-Wesley in November, 1990 and the Claris Corporation in May, 1991.

PREPARING ELEMENTARY TEACHERS TO TEACH MATHEMATICS: A PROBLEM-SOLVING APPROACH

METHODS COMPONENT
PUBLICATIONS AND PRESENTATIONS

Publications Related to the Methods Component

Kloosterman, Peter, & Stage, Frances K. (1992). Measuring beliefs about mathematical problem solving. *School Science and Mathematics, 92*, 109-115.

Kroll, Diana Lambdin, & Leitze, Annette Ricks. (1992). March Calendar (problems 21-24). Mathematics Teacher, 85(3), 203-206.

Kroll, Diana Lambdin, & Leitze, Annette Ricks. (1992). February Calendar (problems 15-29). Mathematics Teacher, 85(2), 123-126, 158-159, 162.

LeBlanc, John F., Leitze, Annette Ricks, & Emenaker, Charles E. (submitted for review, 1991). A mathematics tutorial program: Collaboration between mathematics educators and classroom teachers. *School Science and Mathematics.*

LeBlanc, John F., Leitze, Annette Ricks, & Emenaker, Charles E. (in press). A problem-solving data bank: Computer support for mathematical problem solving in the elementary school classroom. *Educational Technology.*

Presentations Related to the Methods Component (in order from most recent)

Kloosterman, Peter, Gorman, Jacqueline, & Cougan, Monica (October, 1991). Connecting the classroom with the field in elementary teacher education. *Regional Meeting of the National Council of Teachers of Mathematics,* Louisville, Kentucky.

[This presentation discussed the components at Indiana University (M118, T104, M201, E343) that make up the preservice elementary teacher's mathematics preparation and connected this to the experience at Highland Park Elementary School.]

Kloosterman, Peter, Kroll, Diana Lambdin, & Cougan, Monica (October, 1991). The Indiana University model for preservice elementary mathematics teachers. *Annual Meeting of the Indiana Council of Teachers of Mathematics,* Indianapolis, Indiana.

[This presentation described each of the courses that make up the Indiana University mathematics component for elementary teachers (M118, T104, M201, E343). Connections were made between the courses and the effect of T104 on the methods and field experiences was described.]

Gorman, Jacqueline, & Cougan, Monica (March, 1991). Monster, popcorn and Big Macs: An elementary math fair idea. *Regional Meeting of the National Council of Teachers of Mathematics,* South Bend, Indiana.

Pritchett, Margaret, & Cougan, Monica (November, 1989). Monsters, popcorn and Big Macs: An elementary math fair idea. *Inservice meeting at Saint Richards Elementary School,* Indianapolis, Indiana.

Pritchett, Margaret, & Cougan, Monica (October, 1989). Monsters, popcorn and Big Macs: An elementary math fair idea. *Annual Meeting of the Indiana Council of Teachers of Mathematics,* Indianapolis, Indiana.

[The three references above refer to "how to" presentations which discussed the philosophy of doing a school math fair. The teachers were actively involved in the solution of some actual math fair problems. A packet of potential math fair problems was distributed and discussed, as was a schedule and collection of ideas on organizing a math fair.]

PREPARING ELEMENTARY TEACHERS TO TEACH MATHEMATICS: A PROBLEM-SOLVING APPROACH METHODS COMPONENT

Description of Products Related to the Methods Component

Early Field Experience Instructor's Manual

An instructor's manual was developed for use by the M201 (early field experience) instructors. The manual provides organizational features of the course, teacher notes for each weekly meeting, practical hints and suggestions and model lesson plans. (See p. 5-7 of this report for more details.)

Note: The M201 Early Field Experience Manual is available in hard copy (for the cost of photocopying and optional hole punching or binding plus $2 plus postage) by contacting any *Kinkos* copy center in the nation and telling them that the book is on file in the Bloomington, Indiana *Kinkos*, 113 N. Dunn St., 812 339-3773. *Kinkos* is a nation-wide photocopy chain usually listed in the yellow pages of the phone book under "printers."

Model Lesson Plans and Videos

Four model lesson plan series were developed for M201 (early field experience). Each series is composed of three lessons on a specific topic and has an accompanying videotape. The three lessons are for primary (K - 2), intermediate (3 - 4), and upper elementary (5 -6). See the list below. For more details see pp. 7-9 of this report.)

Graphing Series		Geometry Series	
K-2	Bar Graphing	K-1	Shape Recognition
3-4	Coordinate Grid	2-4	Line Symmetry
5-6	Frequency Distribution	5-6	Three-Dimensional Shape Recognition
Number Theory Series		**Rational Number Series**	
K-1	Odd and Even Numbers	K-2	Introduction to Rational Numbers
2-4	Prime and Composite	3-4	Rational Numbers Using Region Models
5-6	Figurative Numbers	5-6	Rational Numbers Using a Relational Perspective

Problem Databank

The computer databank consists of 474 mathematics problems: 109 primary problems, 204 intermediate problems, and 161 advanced problems, which can be searched, sorted, and printed out according to a wide variety of characteristics. See pp. 19-26 of this report for a detailed description of the databank. Note: it is essential to have Filemaker II software to use this databank of problems.